



SPACE LAUNCH SYSTEM

APRIL 2018

INTERIM CRYOGENIC
PROPULSION STAGE

ULA

TWO FOR THE SHOW

ORION STAGE ADAPTER SHIPS TO KENNEDY

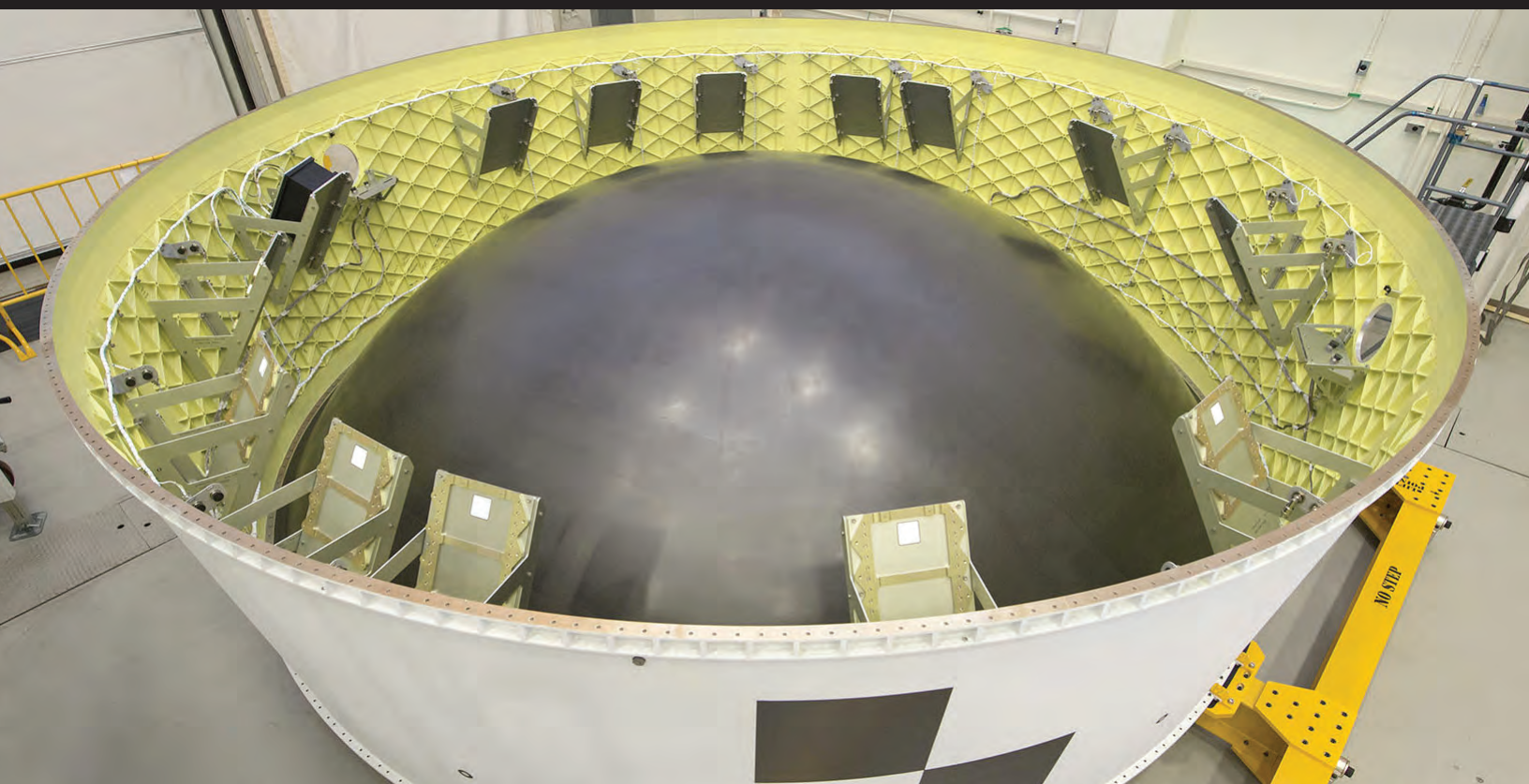


The SLS Program delivered the Orion stage adapter to Kennedy Space Center's Exploration Ground Systems (EGS) Program in early April. And just like that, Exploration Mission-1 (EM-1) and the SLS Block 1 vehicle are one step closer to the launch pad. NASA's Super Guppy aircraft transported the adapter, which measures 18 feet in diameter by 5 feet high, from Redstone Arsenal Airfield near NASA's Marshall Space Flight Center to Kennedy, where 13 CubeSat secondary payloads will be installed.

After the small science experiments and technology demonstrations destined for deep space are incorporated into the adapter, technicians will stack the Orion stage adapter on the interim cryogenic propulsion stage. The [interim cryogenic propulsion stage](#), completed and delivered to EGS in 2017, is a liquid hydrogen/liquid oxygen upper stage that will give

Orion its push toward the Moon, inserting it into a trans-lunar trajectory. The Orion stage adapter connects the interim cryogenic propulsion upper stage to Orion, NASA's new spacecraft built to send astronauts to the Moon on missions that will provide a foundation for deep-space exploration.

For EM-1, the Orion stage adapter will house the [13 CubeSat payloads](#) and an avionics unit that will send signals to each payload, triggering its deployment at the appropriate point along the trajectory after Orion has separated from the interim cryogenic propulsion stage. About the size of large shoeboxes, these small but mighty science experiments and technology demonstrations will perform a variety of missions, including mapping lunar resources and studying space weather and a near-Earth asteroid.



SLS WELCOMES NEW ADMINISTRATOR JIM BRIDENSTINE TO THE NASA FAMILY!



RUMAASHA MAASHA TAKES SAFETY TO A DEEPER LEVEL

At NASA, safety is part of everyday conversations and is reflected in the attitudes and behaviors of the workforce, creating a strong safety culture. When Rumaasha Maasha, an aerospace engineer in Marshall Space Flight Center's Spacecraft & Vehicle Systems Department, noticed a problem on a recent commercial flight, he alerted the crew and the plane safely returned to Huntsville, Alabama.

At Marshall, Maasha specializes in structural dynamics, specifically with loads analysis and modal and vibro-acoustics testing. Recently, Maasha was part of the team that performed modal testing on the [integrated spacecraft and payload element structural test article stack](#) — precursor testing for the Orion stage adapter flight hardware recently transported to NASA's Kennedy Space Center.

Read the full story: go.nasa.gov/2JVw2sy





MOVING PIECES OF THE WORLD'S LARGEST ROCKET STAGE

Before all the fire and smoke on launch day when SLS and Orion climb to space at more than 17,500 miles per hour, the world's largest rocket stage is going places on Earth at a much slower pace, thanks to specially designed ground support equipment.

Even though SLS is designed to fly into space at thousands of miles per hour and withstand the loads of launch and ascent, moving the hardware by land or water stresses the parts in a different way. "Ground transportation and barge load cases produce significant concentrated loads at attachment points that are perpendicular to the direction of flight loads that the vehicle was mainly designed for," explains David Adcock, manager of SLS core stage ground support equipment. "You have to protect against loads the hardware may not actually see in flight. SLS was designed to fly in a certain way that it may not experience on the road."

NASA's SLS Program depends on the specially designed ground support equipment to safely move all core stage test and flight hardware — including the core stage pathfinder — between the manufacturing floor at Michoud Assembly Facility, test facilities at Stennis Space Center and Marshall Space Flight Center and the launch site at Kennedy Space Center.

Continued on next page

For the 212-foot core stage — the largest rocket stage ever built — ground support equipment includes a set of modular tools ranging from smaller brackets, shackles and pins that secure the giant rocket hardware to the mammoth motorized transports that move rocket components between buildings, the Pegasus barge and test stands at a slow but safe pace. There is even a test load facility at Michoud, NASA's rocket factory, where the entire set of transportation equipment is tested to make sure it can handle the ground and sea transportation loads of SLS core stage components.

Like the flight hardware that depends on it, the ground support equipment was designed and built to exact specifications, and detailed use instructions are documented for every move and carefully choreographed by the operations teams.

Primary ground support equipment components include motorized transporters, several hardware interface structures and a multipurpose carrier that provides a platform for mounting the interface structures and attach points for the motorized transporters. Working together, the ground support equipment prevents, absorbs and compensates for the loads and stresses due to pitching, yawing and rolling during ground and sea transportation.

Primary components of the transport system include motorized transporters, several hardware interface structures and a multipurpose carrier that provides a platform for mounting the interface structures and attach points for the motorized transporters.

The four motorized transporters (named Elpis, Novus, Pandora and Aegis) always work in pairs – two in front and two in back – to keep one-of-kind spaceflight hardware level. Each transporter is about 33 feet long and 12 feet wide and can carry 75 tons. Each transporter has 24 electric wheels powered by a propane-driven engine and all wheels are driven independently to smooth the ride and make tight turns as needed. The driver walks alongside with a joystick, guiding the transporters at that sloth-like pace of just over one mile per hour.

Other types of ground support equipment include specialized brackets and beams for lifting and installing qualification and flight hardware into test stands at Marshall, Stennis and integration facilities at Kennedy. Among those is the forward lifting spider, a circular, multi-legged structure that attaches to the top of the core stage to lift it into and out of test stands.

The rocket may be new, but the team at Marshall draws on years of experience moving large spaceflight hardware. “We’ve had a ground support equipment design team here for many years,” explains Engineering Ground Support Equipment Manager Shane Carpenter. “The hardware is different, but the path the ground support equipment has to take is well-understood. This ground support equipment represents a great team effort!”



Designing and building ground support equipment to move the mammoth SLS fuel tank required analyzing stresses on the ground that differ from spaceflight.



Hardware interface structures, part of an integrated multipurpose transportation system, cradle one-of-kind spaceflight hardware to ensure it safely moves from production to testing or launch facilities.



Custom-designed ground support equipment is vital to moving full-scale test hardware and usually travels with structural articles.

TO THE MOON AND BEYOND

SLS and Orion are America's space vehicles and the foundation for missions carrying explorers to deep space. This new era of discovery requires all of humanity, including international and commercial partners, to help make these ventures possible and sustainable. Partners can help provide routine delivery of supplies and equipment needed to live and work on the Moon and in deep space. SLS and Orion are planned to fly once or twice a year and will focus on dependable, safe flights for humans and large cargo.

America and the world are ready for this new era of space exploration. The Apollo Program gave humanity a taste of traveling to a foreign world. NASA's planetary probes and great observatories have begun to reveal the universe in all its mystery. One hundred and thirty-five NASA space shuttle missions, 20 years building the International Space Station — the largest structure ever constructed in orbit — and 18 years of continuous human presence in low-Earth orbit have helped us learn to be space beings. Our next adventure starts when SLS roars off the launch pad, opening a new era of human exploration and discoveries.

A deep space mission requires a rocket that can travel beyond low-Earth orbit with enough power and speed to overcome the pull of Earth's gravity and send the spacecraft even farther to reach the Moon. The key maneuver that makes it possible to send Orion 280,000 miles beyond Earth and 40,000 miles beyond the Moon, farther than any spaceship qualified to safely carry humans has ever ventured, is called a trans-lunar injection, or TLI.

Check out the new web page for all things lunar exploration:
[go.nasa.gov/2rj5A1C](https://www.nasa.gov/2rj5A1C)



MARS GENERATION LAUNCHES

More than eight months of planning, proposal writing, design, engineering, safety reviews and test flights culminated in the roars of student-built rockets in the cotton fields of North Alabama in early April. NASA's annual Student Launch competition, sponsored by Orbital ATK, gives the next generation of rocket scientists a chance to design, build, launch and fly payloads on student-built rockets. Rockets reach for an altitude of 5,280 feet above ground level. Senior Team Lead Zachary Lewis from the United States Naval Academy, in Annapolis, Maryland, said he appreciated the experience and thinks human exploration of the Moon should be a priority. "Space exploration also allows us to put our differences aside and do something together," he noted.

Junior Nathan Cox from North Carolina State University in Raleigh, North Carolina, echoed those sentiments. "It's exciting to see our country moving space exploration forward again, especially since it's been so long since we left low-Earth orbit. I can't wait to see humans step on the Moon or another planet in my lifetime!"

Learn how SLS benefits from the rocket challenge and learn about the teams that competed and the winners here: go.nasa.gov/2HTeiS4



WHAT'S NEW IN SLS SOCIAL MEDIA

NASA'S ROCKET SCIENCE IN 60 SECONDS FACEBOOK PAGE



Learning rocket science can be a challenge, but NASA and the SLS Program are here to help you out with a new video series called “Rocket Science in 60 seconds.” Topics covered so far include thermal protection (spoiler alert: that’s rocket science for “insulation”), the Orion stage adapter where 13 shoebox-sized payloads will get a ride to deep space on the first mission and astronaut Butch Wilmore discussing all the testing that goes into making the rocket safe for humans.

SPACEFLIGHT PARTNERS: *Ducworks, Inc.*

NUMBER OF EMPLOYEES: 64

LOCATION: *Logan, Utah*

WHAT THEY DO FOR SLS: Ducworks, Inc. performs tooling, ground support equipment, testing equipment and manufacturing support.



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MAY

Go inside the intertank structural test article

Boosters progress for first two missions

Connecting with launch and mission control